U.S. Fish & Wildlife Service

Abundance and Run Timing of Adult Salmon in Henshaw Creek, Kanuti National Wildlife Refuge, Alaska, 2000

Alaska Fisheries Data Series Number 2005–1

Fairbanks Fish and Wildlife Field Office
Fairbanks, Alaska
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Abstract

A resistance board weir was operated between July 8 and August 13, 2000 to collect abundance, run timing, and biological information from salmon returning to Henshaw Creek, a tributary of the Koyukuk River in north-central Alaska. This was the first year of operating a weir at this location. A total estimate of 193 Chinook salmon *Oncorhynchus tshawytscha* and 24,406 summer chum salmon *O. keta* passed through the weir. Four resident species were counted with longnose sucker *Catostomus catostomus* the most abundant (N=325), followed by Arctic grayling *Thymallus arcticus* (N=21), northern pike *Esox lucius* (N=4), and whitefish *Coregonus* spp. (N=1). The median date of passage for Chinook salmon was July 16. The Chinook salmon run was composed of 20% females. The age distribution was predominately age 1.3 (63%). The median date of passage for chum salmon was July 22. The chum salmon run was composed of 57% females. The age distribution was predominately age 0.3 (57%) and 0.4 (42%).

Introduction

Henshaw Creek provides spawning and rearing habitat for Chinook *Oncorhynchus tshawytscha* and chum *O. keta* salmon. Henshaw Creek is located within the Kanuti National Wildlife Refuge (Refuge) and is a major tributary flowing into the Koyukuk River drainage. The Refuge is located near the villages of Allakaket, Alatna, and Bettles in north-central Interior Alaska. Chinook and chum salmon from Henshaw Creek contribute to the mixed stock subsistence and commercial fisheries occurring in the Yukon River drainage (USFWS 1993). Prior to this study, the relative extent of that contribution was unknown.

Within federal conservation units, continued subsistence use by rural residents of fish and wildlife resources and the conservation of those resources are mandated in the Alaska National Interests Lands Conservation Act (1980). Declines of Yukon River salmon stocks that began in the late 1990s (Kruse 1998) have led to harvest restrictions, complete fishery closures, and spawning escapements below management goals (JTC 2000). The year 2000 escapement was the third consecutive year of poor returns for Chinook salmon and the fourth year for summer chum salmon. For chum salmon, the declining returns in 1998-2000 followed three years of high escapement parent stocks from 1994 through 1996. In the mixed stock fishery of the Yukon River, overfishing of some salmon stocks may have contributed to their decline. Management of individual stocks does not occur and accurate escapement data are limited throughout the Yukon River drainage. Escapement estimates are primarily from aerial surveys (Barton 1984) which are highly variable and are only an index of relative run strength. The in-season management of the salmon fisheries is conducted on information provided from the preseason outlook based on parent stock returns, test fisheries, Pilot Station sonar, run strength from lower river escapement projects, and subsistence and commercial harvest reports (Vania and Golembeski 2000).

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Additional escapement projects using fish weirs and counting towers are being established in the Yukon River drainage. These projects provide accurate information for evaluation of management practices. Prior to 1999, three stock status and escapement projects were conducted in the Koyukuk River drainage to enumerate salmon stocks; the Gisasa River weir (Wiswar 2001), South Fork Koyukuk River weir (Wiswar 1998), and the Clear Creek counting tower (C. Kretsinger, Bureau of Land Management, Fairbanks, personal communication). After 1997, the South Fork Koyukuk River weir study was abandoned due to persistent high water events that prevented operation of the project. In 1999, a counting tower was operated on Henshaw Creek but funding was for only that year (VanHatten 1999; Appendix 1). In 2000, it was decided that the best use of the weir formerly used on the South Fork Koyukuk River would be on Henshaw Creek, where high water events would be less likely to compromise the performance of the weir and still maintain an escapement project in the upper Koyukuk River drainage. Additionally, Henshaw Creek is classified as an index stream for Chinook and summer chum salmon (ADF&G 2000) where there is historic information on salmon escapement. Aerial survey estimates for escapements in Henshaw Creek since 1960 ranged from six to 593 Chinook salmon and 12 to 15,397 chum salmon (Barton 1984; Appendix 1). In 2000, the objectives of the Henshaw Creek weir were to determine (1) daily escapement and run timing of adult salmon, (2) age, sex, and length (ASL) compositions of adult salmon, and (3) the upstream movement of resident fish.

Study Area

Henshaw Creek is a small clear water tributary of the Koyukuk River in north-central Alaska (Figure 1). The headwaters originate in the Alatna Hills and the river flows southeasterly for 144 km before entering the Koyukuk River. The climate of this area is cold and continental, which is characterized by extreme seasonal temperature variations and very low precipitation. There is an extreme range in air temperature with recorded temperatures from 18° to 21° C in summer months to recorded lows of -57° C in winter months (USFWS 1993). Stream flows are highest during the spring months in response to snow melt with sporadic high discharge periods throughout the summer in response to local rain showers.

Channel configuration is typically meandering with alternating cut banks and gravel bars. The substrate is primarily medium to large gravel (8 - 64 mm) and cobble in the higher velocity currents and sand and silt in the pools. The weir site is approximately 1.5 km upstream from the mouth of Henshaw Creek. The width of the channel at the weir site is about 30 m with an average depth of 0.6 m during most of the summer of 2000.

Methods

Weir Operation

A resistance board weir was operated to collect biological information from adult salmon and resident species as they migrated into Henshaw Creek. Construction and installation of the weir was described by Tobin (1994). Each picket of the weir was schedule 40 polyvinyl chloride (PVC) electrical conduit with a 2.5 cm inside diameter and spaced 3.2 cm between individual pickets (Wiswar 2001). Visual inspection of the weir was conducted on a daily basis for holes and structural integrity. During visual inspection, the weir was cleaned of debris and fish carcasses. A live trap, installed near mid-channel, allowed salmon and resident species to pass upstream when open.

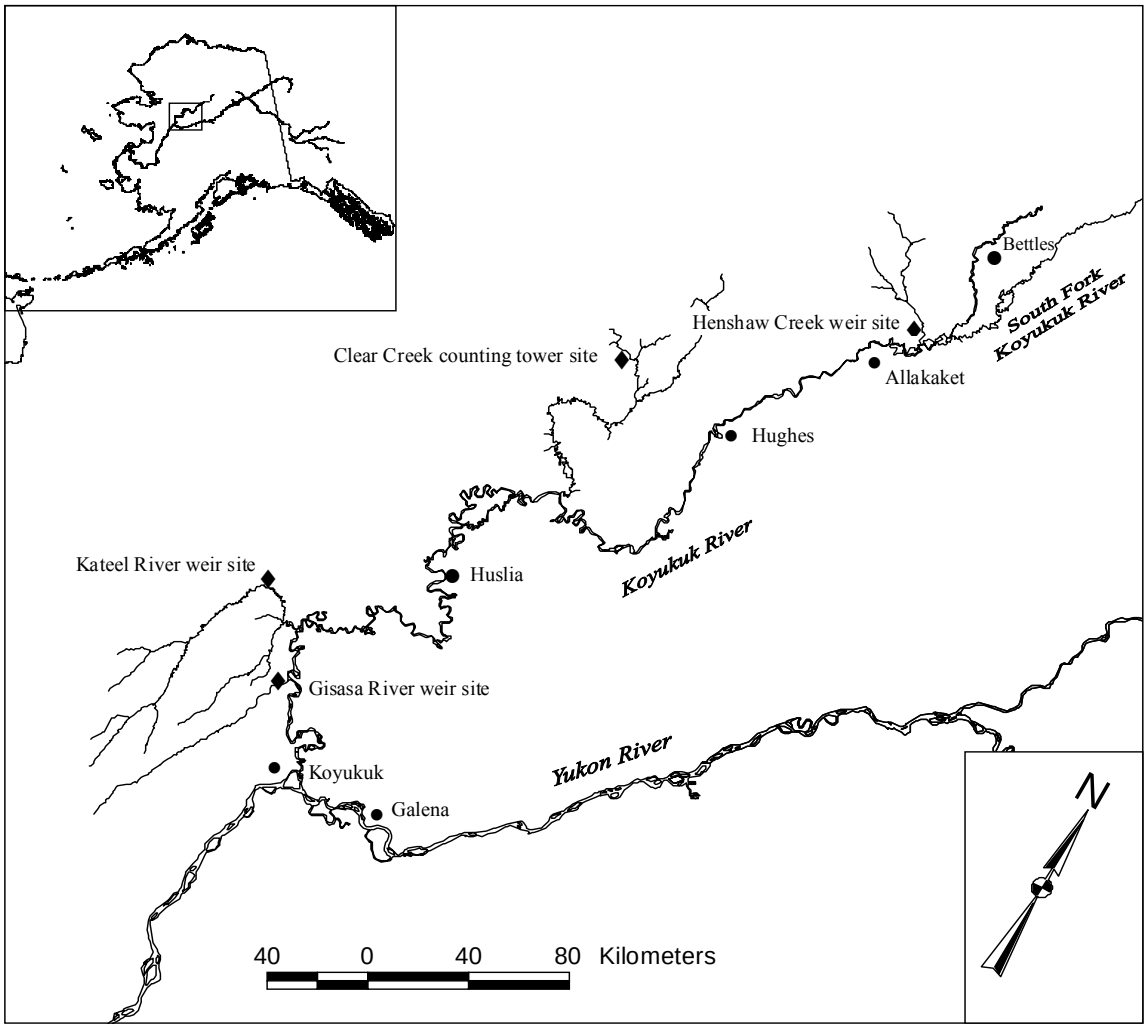

Figure 1. Location of weir site, Henshaw Creek, Alaska.

Biological Data

Abundance and run timing of adult salmon were estimated by counting the number of each species of fish migrating through the weir each day. Daily counts began at 0800 hours and ended at midnight. Counting began at the top of the hour and the numbers were recorded each hour. During the time when daily counts were not conducted (0000-0800 hours), the trap was closed to migrating fish.

During those time periods when counting was stopped due to high water, the daily escapement numbers were estimated by linear interpolation (Zar 1984) between the daily count before and after the event.

A stratified random sampling scheme was used to collect age, length, and sex ratio information from both adult salmon species. Calculations for sex and age information were treated as a stratified random sample (Cochran 1977) and statistical weeks were the strata. The first stratum was an exception as the first two days of the weir operation were added to it. Each statistical week was defined as beginning on Monday and ending on Sunday. Sampling began at the beginning of each week and, generally, was conducted over a 3-4 day period to collect the targeted 160 fish/species/week. Daily sex ratios were collected using two methods: 1) sex was recorded when sampling for age and length, and 2) salmon were visually sexed as they swam

through the trap. For sex ratios collected throughout the day, crew members physically handled and sexed the fish as they migrated into the trap. Scales were used for aging salmon and reported using the European technique (Foerster 1968). Three scales were collected from Chinook salmon samples and one scale from chum salmon. Scales were sampled from the area located on the left side of the fish and two rows above the lateral line on a diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin. Scales from both adult salmon species were sent to the Alaska Department of Fish and Game for processing. Lengths of Chinook and chum salmon were measured to the nearest 5 mm from mid-eye to fork of the caudal fin (MEL).

Data Analysis

Within a week, the proportion of the samples composed of a given sex or age, $\hat{p}_{ij}$, were calculated as

$$\hat{p}_{ij} = \frac{n_{ij}}{n_j},$$

where n_{ij} is the number of fish by sex *i* or age *i* sampled in week *j*, and n_j is the total number of fish sampled in week *j*. The variance of $\hat{p}_{ij}$ was calculated as

$$\hat{v}(\hat{p}_{ij}) = \frac{\hat{p}_{ij}(1-\hat{p}_{ij})}{n_j - 1}.$$

Sex and age compositions for the total run of Chinook and chum salmon of a given sex/age, $\hat{p}_i$ were calculated as

$$\hat{p}_i = \sum_{j-1} \hat{W}_j \hat{p}_{ij,}$$

where the stratum weight $\hat{W}_j$ was calculated as

$$\hat{W}_j = \frac{N_j}{N},$$

and N_j equals the total number of fish of a given species passing through the weir during week *j*, and *N* is the total number of fish of a given species passing through the weir during the run. Variance, $\hat{v}(\hat{p}_i)$ of sex and age compositions for the run was calculated as

$$\hat{v}(\hat{p}_i) = \sum_{j-1} \hat{W}_j^2 \hat{v}(\hat{p}_{ij}).$$

Results

Weir Operation

The weir was operational intermittently from July 8 to August 13, 2000. There were three periods when the weir was not operational: July 13-16, July 18-19, and July 29-30. During these time periods, the water level and turbidity increased to a level that prevented viewing migrating fish.

Biological Data

During the study, 193 Chinook salmon, 24,406 chum salmon, and 351 resident fish were estimated as they migrated upstream through the weir (Appendix 2). The most abundant resident species was longnose sucker *Catostomus catostomus* (N=325) followed by Arctic grayling *Thymallus arcticus* (N=21), northern pike *Esox lucius* (N=4), and whitefish *Coregonus* spp. (N=1).

Chinook salmon.—The first Chinook salmon passed the weir on July 10 and the last one was counted on August 6 (Figure 2; Appendix 2). The median migration date was July 16. Females comprised 20% of the run (Table 1). The female sex ratio started low at 15%, and increased throughout the run to 33% during the week of July 31 to August 6. Age composition of the 38 Chinook salmon sampled was made up of three age groups: age 1.3 (63%), age 1.4 (19%), and age 1.2 (19%). Female Chinook salmon ranged from 790 to 915 mm MEL and were larger in length than males which ranged from 460 to 750 mm MEL (Table 2; Figure 3). Sample size was deemed too small for making statistical comparisons.

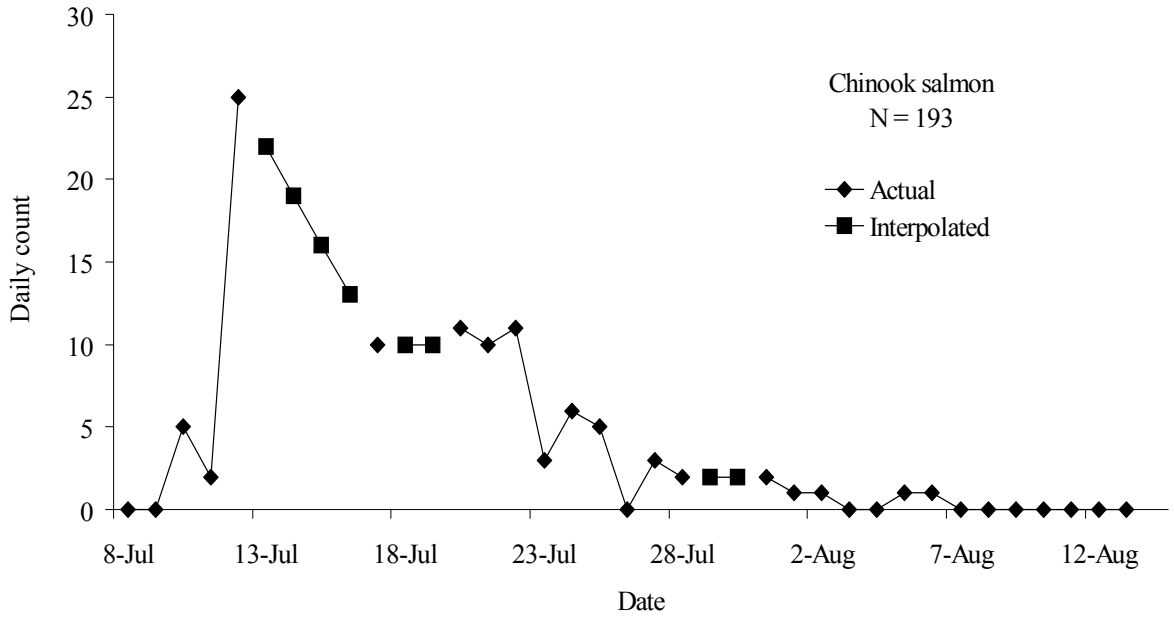

Figure 2. Daily estimates of Chinook salmon migrating passed the weir on Henshaw Creek, Alaska, 2000.

Table 1. Estimated sex ratio of Chinook salmon sampled at Henshaw Creek, Alaska, 2000. SEs are in parentheses.

Time period	Run estimate	N	Percent female	Estimated number of females
July 8-16	102	27	15 (7.0)	15
July 17-23	65	45	24 (6.5)	16
July 24-30	20	16	25 (11.2)	5
July 31-August 6	6	6	33 (21.1)	2
August 7-13	0	0		
Run total	193	94	20 (4.5)	38

Table 2. Length at age of Chinook salmon sampled at Henshaw Creek, Alaska, 2000.

	Female				Male			
		Mid-eye to fork length (mm)				Mid-eye to fork length (mm)		
Age	N	Mean	SE	Range	N	Mean	SE	Range
1.2	0				7	492.1	14.0	460-550
1.3	5	812.0	9.3	790-840	19	661.3	12.9	545-750
1.4	7	830.0	17.0	795-915	0			

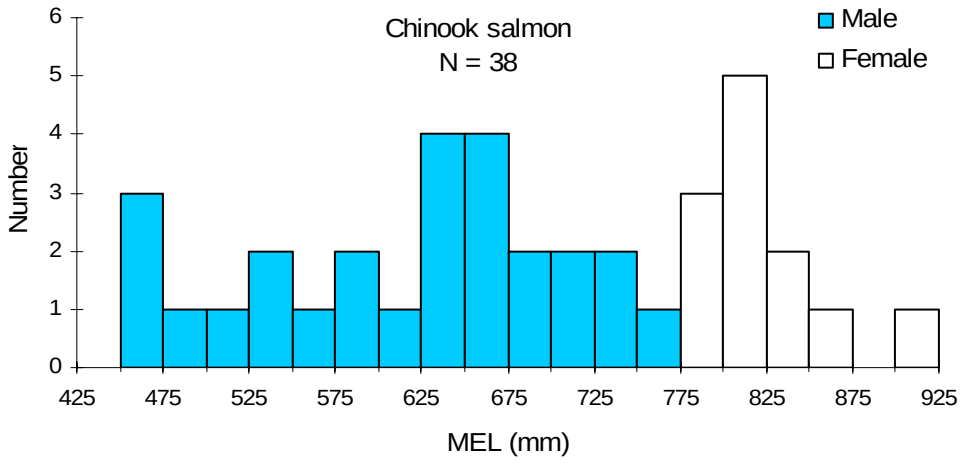

Figure 3. Length frequency histogram of Chinook salmon sampled at Henshaw Creek, Alaska, 2000.

Chum salmon.—Chum salmon were present throughout the operation of the weir, July 8 through August 13 (Figure 4; Appendix 2). The median migration date was July 22. The estimated sex ratio for chum salmon was 57% female for the run (Table 3). The female sex ratio increased from 49% in the early part of the run to 74% in the fifth week. There were 580 chum salmon sampled for age composition with 62 (11%) unreadable. Of the three age groups represented in the run, ages 0.3 (57%) and 0.4 (42%) were predominant (Table 4). Female chum salmon ranged from 430 to 615 mm MEL, and male chum salmon ranged from 500 to 655 mm MEL (Table 5; Figures 5 and 6).

Discussion

The use of a resistance board weir allowed us to meet our objectives and provided data useful for management of Yukon River Chinook and chum salmon; that is, escapements were estimated and biological samples were collected for both salmon species. Although the weir was inoperable for three periods during the season, interpolation for the uncounted days appeared to provide a reasonable estimation of fish passage. Spacing of the pickets was designed to prevent passage of adult salmon but may have permitted resident species to migrate upstream undetected.

The outlook on run strength in the Yukon River for 2000 was anticipated to be weak to below average for both Chinook and summer chum salmon (ADF&G 2000). Data collected from other studies confirmed this anticipated run forecast for both species. As this was the first year of the weir operation, it was not possible to compare run strength. However, an inference can be drawn

from past aerial surveys on Henshaw Creek (Appendix 1) to indicate that there have been more Chinook salmon in the river than the 193 fish estimated in 2000.

The low percentage of returning female Chinook salmon (20%) in Henshaw Creek in 2000 was indicative of that observed in the Gisasa River since 1994 where sex ratios have ranged from 17% to 42% female (Wiswar 2001). The cause of these low sex ratios is unknown, but a contributing factor was thought to be the type of gear commercial and subsistence fishermen were using. However, in 2000, commercial and subsistence fishing periods were severely restricted, and therefore, it is unlikely that gear type contributed much to the skewed sex ratios.

The majority of Chinook salmon in the Yukon River are made up of six-year-old fish, age class 1.4 (Brady 1983). Conversely, the age distribution for Chinook salmon from Henshaw Creek in 2000 was dominated by five-year-old fish, age class 1.3 (63%). Five-year-old fish were also the dominant age group (52%) in the Gisasa River in 2000 (Wiswar 2001).

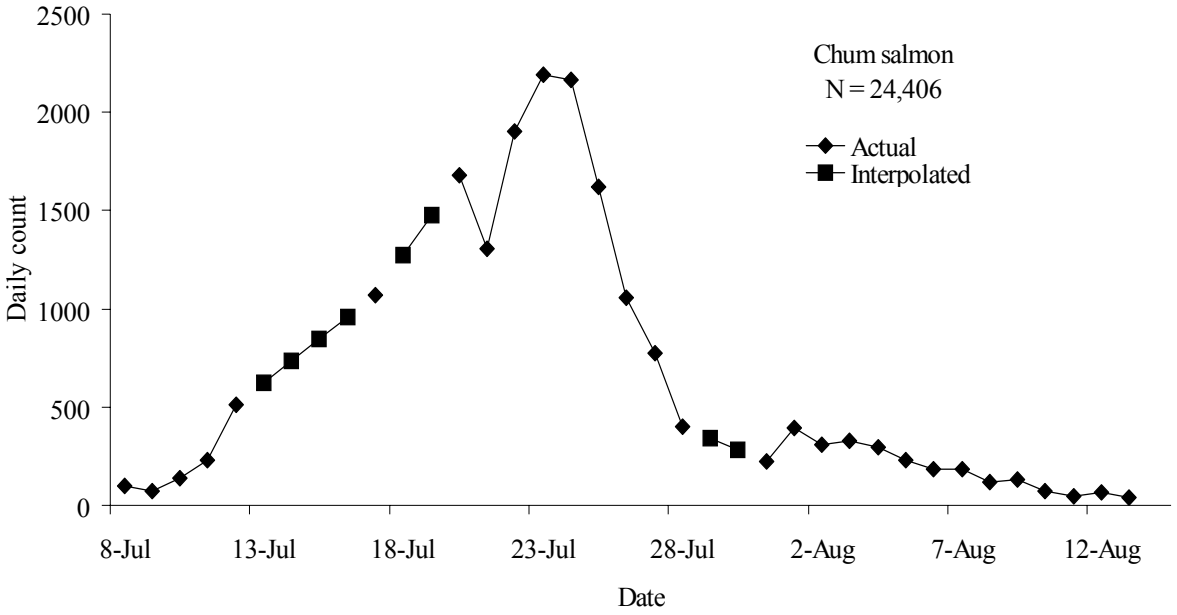

Figure 4. Daily estimates of chum salmon migrating passed the weir on Henshaw Creek, Alaska, 2000.

Table 3. Estimated sex ratio of chum salmon sampled at Henshaw Creek, Alaska, 2000. SEs are in parentheses. The total number of female fish (*) is based on weighted weekly estimates and may not agree mathematically because of rounding errors.

Time period	Run estimate	N	Percent female	Estimated number of females*
July 8-16	4,232	224	49 (3.3)	2,059
July 17-23	10,908	712	58 (1.9)	6,281
July 24-30	6,640	240	59 (3.2)	3,901
July 31-August 6	1,956	310	63 (2.7)	1,237
August 7-13	670	163	74 (3.5)	493
Run total	24,406	1,649	57 (1.4)	14,445

Table 4. Percent weekly age estimates of chum salmon sampled at Henshaw Creek, Alaska, 2000. SEs are in parentheses. Season total is for the period July 17-August 13 as we were unable to obtain samples during the first week.

			Brood year and age		
			1995	1996	1997
Time period	Run estimate	N	0.4	0.3	0.2
July 8-16	4,232	0			
July 17-23	10,908	144	43 (4.1)	56 (4.2)	1 (1.0)
July 24-30	6,640	78	40 (5.6)	59 (5.6)	1 (1.3)
July 31-August 6	1,956	153	38 (4.0)	61 (4.0)	1 (0.7)
August 7-13	670	144	44 (4.1)	56 (4.1)	0 (0.0)
Run total	24,406	519	42 (2.9)	57 (2.9)	1 (1.0)

Table 5. Length at age of chum salmon sampled at Henshaw Creek, Alaska, 2000.

	Female				Male			
		Mid-eye to fork length (mm)				Mid-eye to fork length (mm)		
Age	N	Mean	SE	Range	N	Mean	SE	Range
0.2	3	525.0	8.7	510-540	1	535		
0.3	196	531.3	1.7	445-600	104	561.2	2.7	515-655
0.4	134	545.3	2.4	430-615	80	581.1	3.7	500-655
0.5	0				1	570		

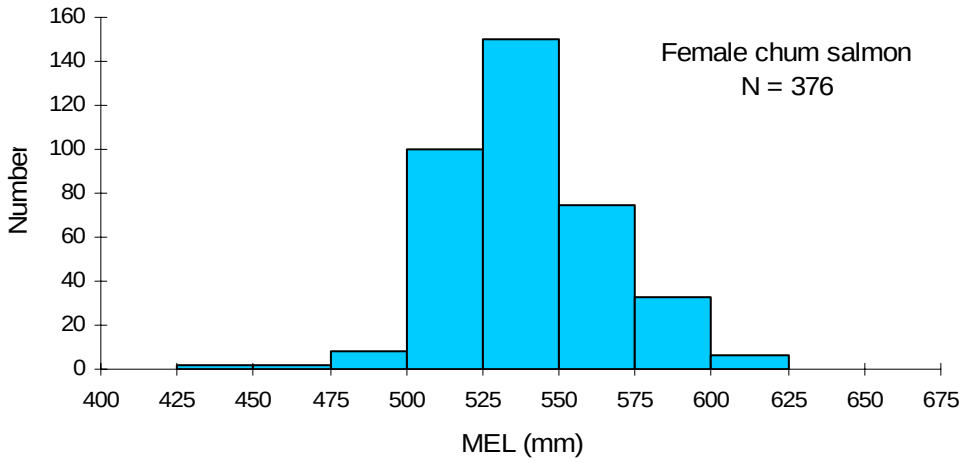

Figure 5. Length frequency histogram of female chum salmon sampled at Henshaw Creek, Alaska, 2000.

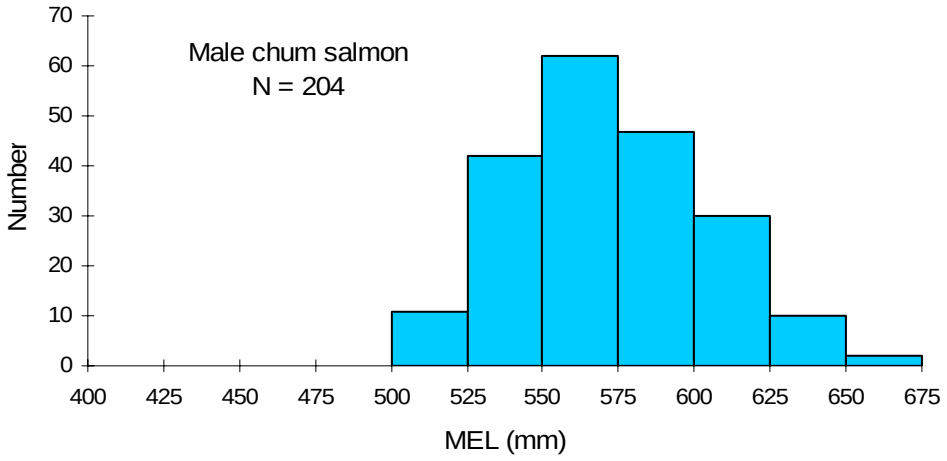

Figure 6. Length frequency histogram of male chum salmon sampled in Henshaw Creek, Alaska, 2000.

Recommendations

We recommended that the crew size be increased to four technicians and the trap operated 24 hours/day with no closures between midnight and 0800 as in 2000. The trap in 2000 was closed (0000-0800) because we did not anticipate a large chum escapement and, therefore, had planned only for a crew of three technicians. A four-person crew would allow for a 24 hour/day count of fish moving through the weir without closing the trap. This would result in minimal delays in upstream movement. Also, an additional person would allow for a technician to assist in sampling fish for ASL which would minimize fish handling during this process. We are also recommending that the weir be moved upstream about 100 meters where the stream banks appear more stable.

Acknowledgments

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Bill Carter and Isaac Solomon were the biological technicians that operated the weir. Bill Carter served as crew chief and was responsible for field activities that included data collection, logistics, and safety. The Kanuti National Wildlife Refuge provided logistical support for the project. David Wiswar and Kevin VanHatten were the project managers. This report was reviewed and edited by Dave Daum and Jeff Adams.

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Appendix 1. Chinook and chum salmon escapements for Henshaw Creek, Alaska, 1960-2000 (source: Barton 1984; VanHatten 1999; Alaska Department of Fish and Game, unpublished data; this study). Aerial surveys are rated as poor, fair, good or any combination when multiple stream reaches were surveyed. Ratings are based on a combination of various environmental conditions: wind, weather, water, visibility, substrate, time, distance surveyed, and spawn stage.

	Aerial surveys			Counting tower		Weir	
Year	Chinook salmon	Chum salmon	Rating	Chinook salmon	Chum salmon	Chinook salmon	Chum salmon
1960	Present		Poor				
1969	6	300	Not rated				
1975	118	1,219	Not rated				
1976	94	624	Fair				
1982	48	12	Fair				
1983	553	3,288	Good-fair				
1984	253	532	Poor				
1985	393	3,724	Good				
1986	561	2,475	Fair				
1987	20	35	Not rated				
1988	180	1,106	Good-poor				
1990	369	1,237	Good-fair				
1991	455	2,148	Good				
1992	Present	Present	Poor				
1993	330	1,173	Good				
1994	526	2,165	Fair				
1995	271	15,397	Good				
1996	69	12,890	Fair				
1997	593	1,800	Fair				
1998	97	151	Fair				
1999	119	2,703	Poor	12	1,510		
2000						193	24,406

Appendix 2. Daily and cumulative (Chinook and chum salmon only) estimates of fish passing the Henshaw Creek weir, Alaska, 2000. Interpolated estimates (*) included in total number of fish species estimated. (Cum = cumulative).

	Chinook salmon		Chum salmon		Longnose sucker	Arctic grayling	Northern pike	Whitefish spp.
Date	Daily	Cum	Daily	Cum	Daily	Daily	Daily	Daily
July 8	0	0	101	101	51	3	0	0
July 9	0	0	75	176	175	2	0	0
July 10	5	5	141	317	20	3	0	0
July 11	2	7	229	546	11	2	0	0
July 12	25	32	514	1,060	21	1	0	0
July 13 *	22	54	626	1,686	17	1	0	0
July 14 *	19	73	737	2,423	13	1	0	0
July 15 *	16	89	849	3,272	9	1	1	0
July 16 *	13	102	960	4,232	5	1	1	0
July 17	10	112	1,072	5,304	2	1	1	0
July 18 *	10	122	1,276	6,580	1	1	1	0
July 19 *	10	132	1,479	8,059	0	0	0	0
July 20	11	143	1,683	9,742	0	0	0	0
July 21	10	153	1,306	11,048	0	1	0	0
July 22	11	164	1,903	12,951	0	0	0	0
July 23	3	167	2,189	15,140	0	1	0	0
July 24	6	173	2,167	17,307	0	0	0	0
July 25	5	178	1,619	18,926	0	0	0	0
July 26	0	178	1,105	19,980	0	0	0	0
July 27	3	181	775	20,755	0	0	0	0
July 28	2	183	402	21,157	0	0	0	0
July 29 *	2	185	342	21,499	0	0	0	0
July 30 *	2	187	281	21,780	0	0	0	0
July 31	2	189	221	22,001	0	0	0	0
August 1	1	190	394	22,395	0	0	0	0
August 2	1	191	307	22,702	0	0	0	0
August 3	0	191	325	23,027	0	0	0	0
August 4	0	191	293	23,320	0	0	0	0
August 5	1	192	232	23,552	0	0	0	0
August 6	1	193	184	23,736	0	0	0	0
August 7	0	193	186	23,922	0	0	0	0
August 8	0	193	121	24,043	0	0	0	1
August 9	0	193	131	24,174	0	1	0	0
August 10	0	193	75	24,249	0	0	0	0
August 11	0	193	47	24,296	0	0	0	0
August 12	0	193	68	24,364	0	1	0	0
August 13	0	193	42	24,406	0	0	0	0
Run total		193		24,406	325	21	4	1